JAXA TRMM/GPM Program Status

Riko Oki and Takuji Kubota
(JAXA/EORC)

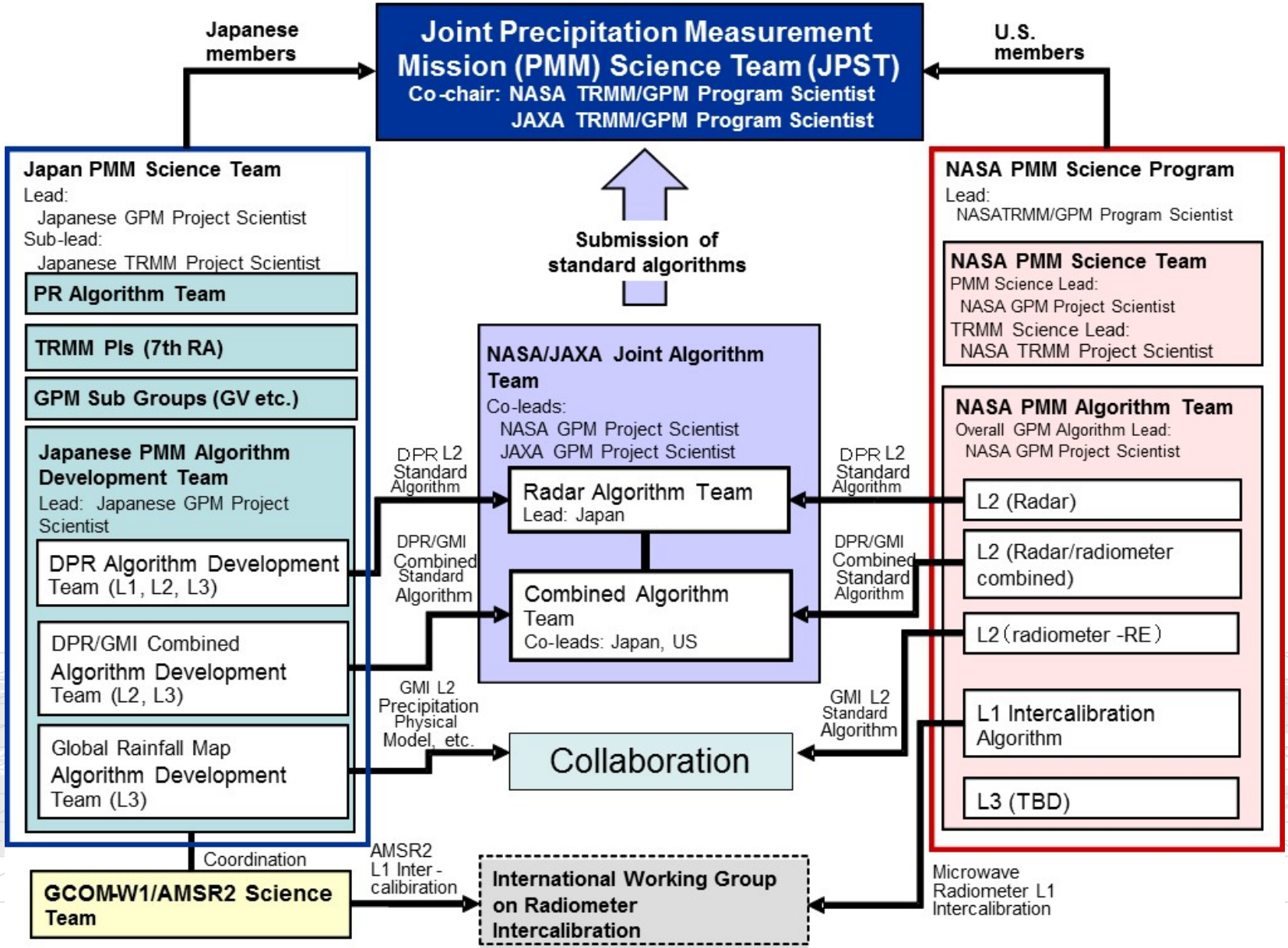
2018 PMM Science Team Meeting, October 2018

Japanese PMM Science Team

- The current Japanese PMM Science Team started in Apr. 2016 for three-year period.
  - 41 proposals for the 8th RA (JFY2016-2018)
    - It is the 8th RA since the first TRMM RA, and the 4th as PMM
  - 30 with research cost proposals
  - 13 no cost transfer proposals including 10 from abroad
- The next RA will be announced in this mid-October for the three-year period JFY2019-2021.
  - The JAXA will integrates Research Announcements for various missions and release "Research Announcements on the Earth Observations".
  - This RA includes almost all EO missions in the JAXA (GPM, GCOM-W, AMSR3, GCOM-C, EarthCARE, ALOS-2/3/4, and MOLI). Deadline is the end of November 2018.
  - https://www.eorc.jaxa.jp/en/research/ra/2nd_ra_eo/index.html

Japan and U.S. PMM Science Framework

-- two joint algorithm development teams --



GPM Algorithm Development Status (Summary)

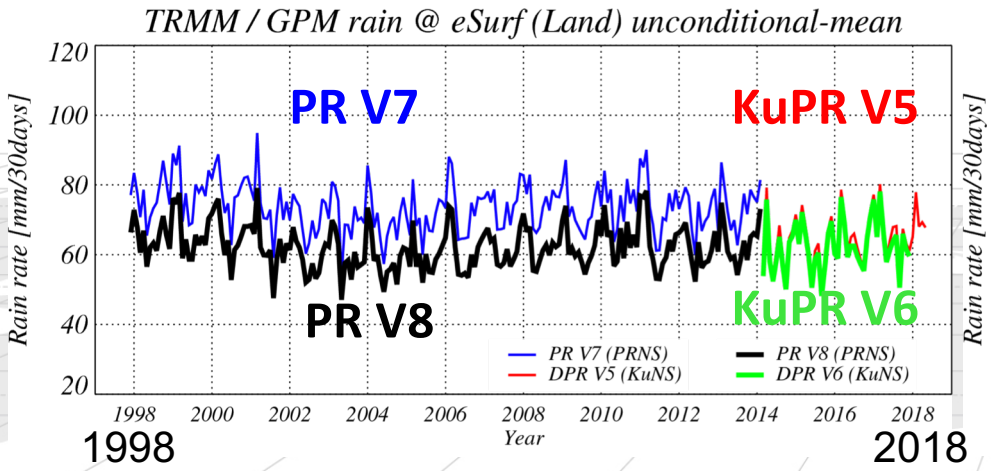
- DPR Level 1 algorithm (JAXA)
  - V05 product was released in May 2017.
- DPR Level 2 and 3 algorithm (Joint Japan-U.S.)
  - V06 product was released in Oct. 2018.
- DPR/GMI combined Level 2 algorithm (Joint Japan-U.S.)
  - V06 product was released in Oct. 2018.
- DPR Latent heating algorithm (Japan-U.S.)
  - DPR Spectral Latent Heating (SLH) V06 product was released in Oct. 2018.
- Global Rainfall Map algorithm [GSMaP] (Japan)
  - V04 Product was released in January 2017.

- TRMM/PR Level 1 algorithm (JAXA)
  - V8 (GPM TRMM V05) product was released in Oct. 2017.
- TRMM/PR Level 2 and 3 algorithm (Joint Japan-U.S.)
  - V8 (GPM TRMM V06)product was released in Jul. 2018.
- TRMM Latent heating algorithm (Japan-U.S.)
  - PR SLH V08 (GPM TRMM V06) product was released in Jul. 2018.

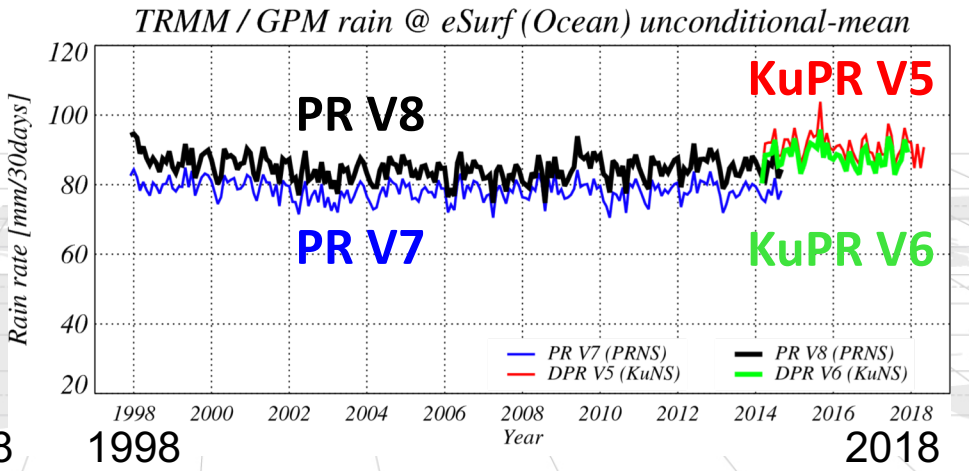
Better continuity of the TRMM/PR (1997-2015) and the GPM/DPR (2014-)

- GPM/DPR's calibration factors was changed in V05 released on May 2017, and TRMM/PR's calibration factors was also changed in TRMM/PR V8 (GPM TRMM V05) L1 released on Oct. 2017.
- Better continuity was realized in the TRMM/PR V8 (GPM TRMM V06) and GPM/DPR V06 released in this October, by using common algorithms between the TRMM/PR and the GPM/KuPR.

Over-land surface precipitation rates averaged in 35S-35N.



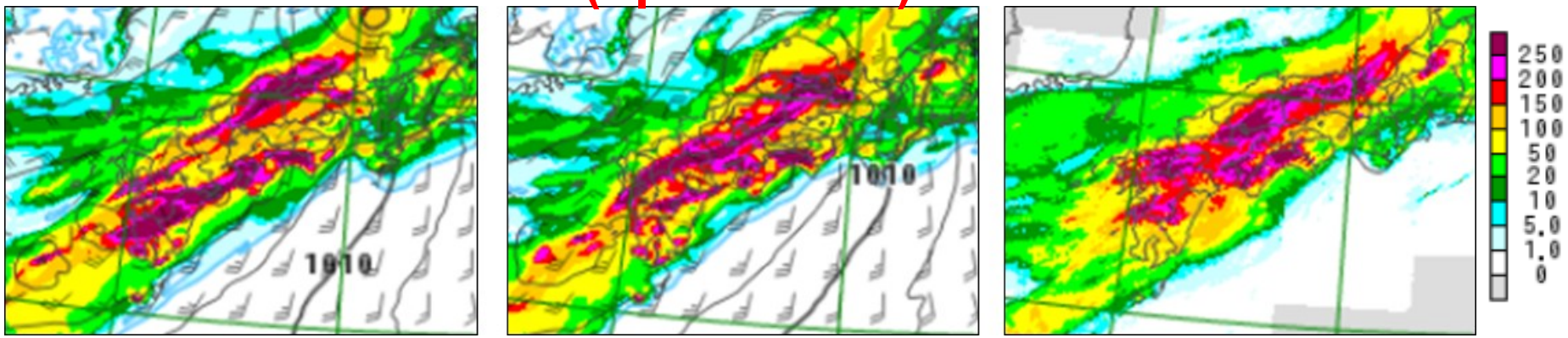
Over-ocean surface precipitation rates averaged in 35S-35N.



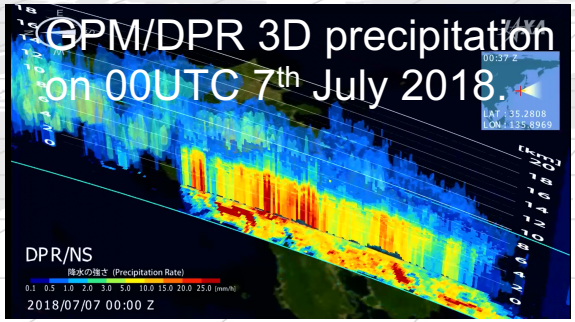
Utilization of DPR Data in the NWP

- ✓ The Japan Meteorological Agency (JMA) started the DPR assimilation in the meso-NWP system on March 24 2016.
- ✓ Figures show the case study for **heavy rainfall in July 2018**, causing serious damage in western part of Japan.
- ✓ Precipitation forecast was similar to the actual precipitation when DPR data was assimilated.

without DPR | **with DPR (operational)** | **Ground observation**



24h forecasts of precipitation (00UTC 7th July 2018) provided by JMA

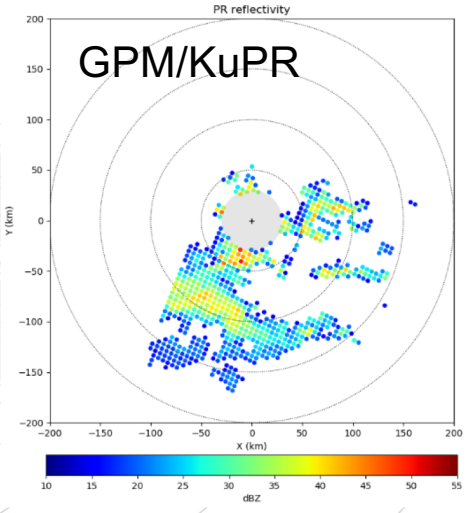


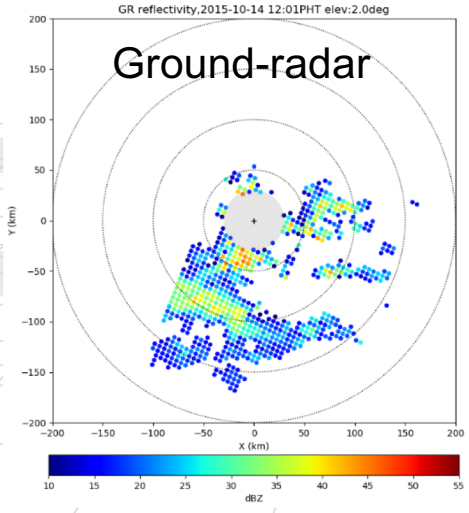
GPM/DPR 3D precipitation on 00UTC 7th July 2018.

Assimilation of GPM/DPR improved the prediction of rainfall location in meso-scale, which is important for disaster prevention.
The DPR 3-dimensional information which cannot be detected by microwave radiometer is essential factor for rainfall forecasting as well as disaster prevention.

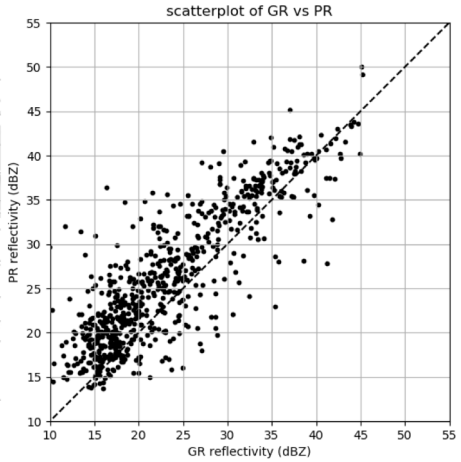
Calibration of the ground radar using the DPR

- Results of **Australian Weather Radar network** using the spaceborne radars
  - Warren et al., 2018: Calibrating Ground-Based Radars against TRMM and GPM. *J. Atmos. Oceanic Technol.*, 35, 323-346, https://doi.org/10.1175/JTECH-D-17-0128.1.
- We invited Tom Kane (BoM) to present their activity in 7th GPM Asia Workshop on Jan. 2018.
- We're applying their method using the wradlib (An Open Source Library for Weather Radar Data Processing) to the ground radar data in Asia/Oceania regions such as the Philippines.

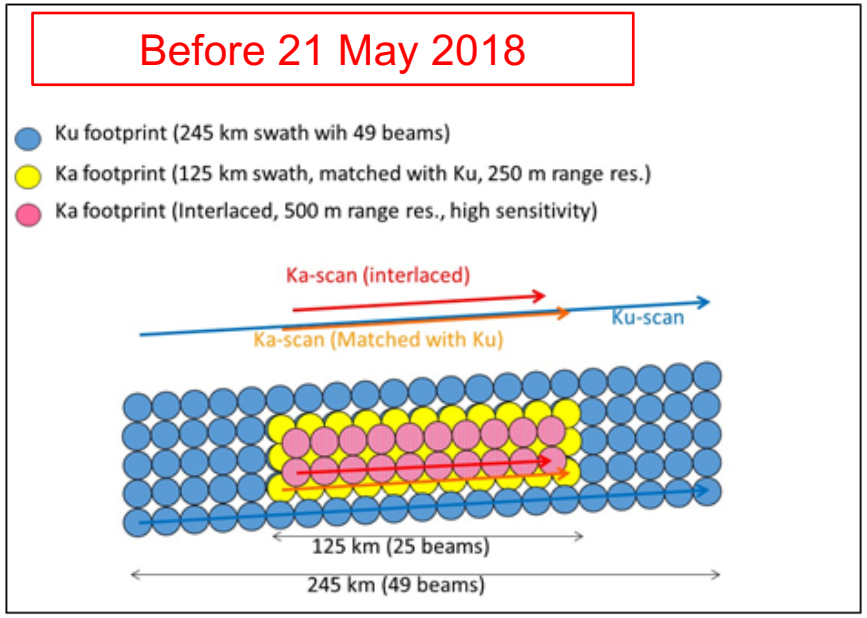


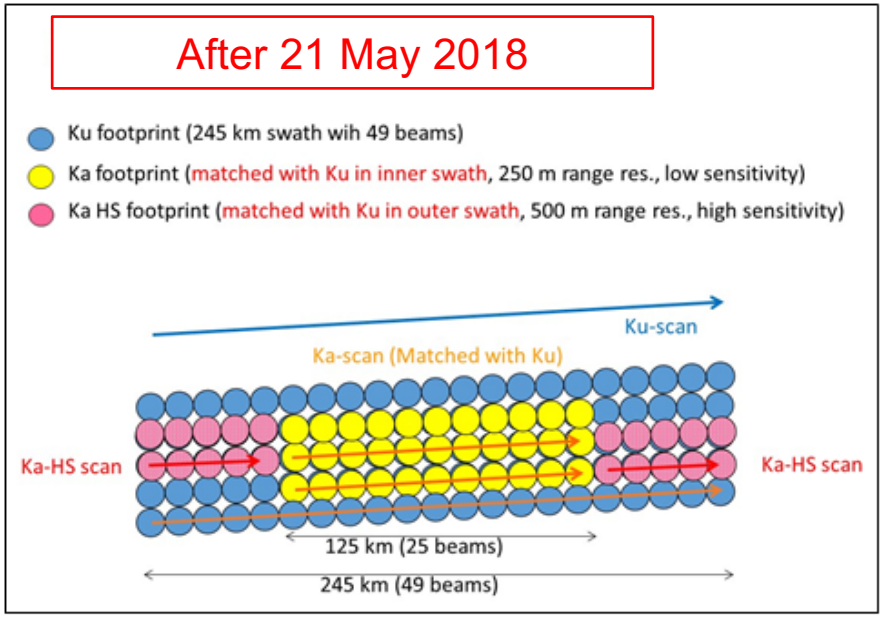


Scatter plot in Z of Ground-radar vs GPM/KuPR



KaPR's scan pattern change (May 2018)





Major changes (item A):

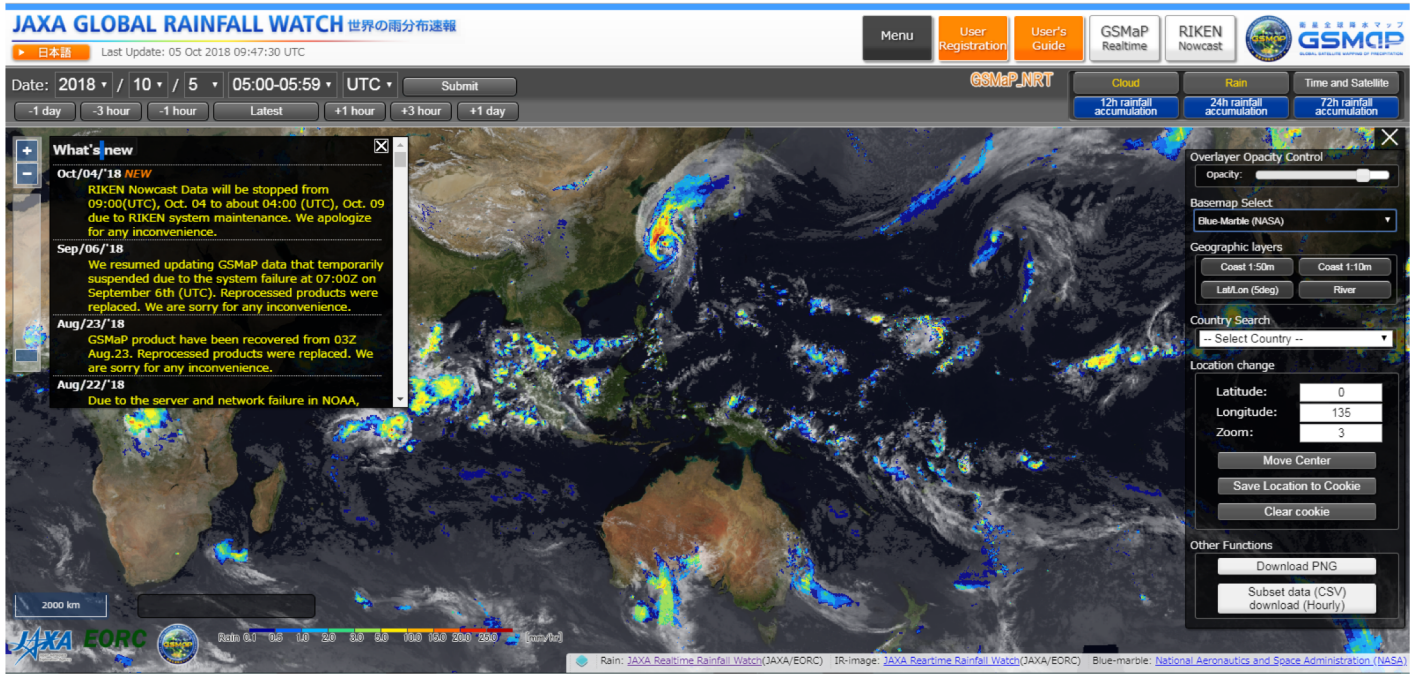
- KaPR-HS's scan pattern was changed.
  → Dual-frequency technique will be applied in a full swath.

Minor changes (item B):

- Scan angle of KaPR-MS scan was changed to realize improvement of beam matching between KuPR and KaPR (by a request from the DPR-L2 algorithm team).

Global Satellite Mapping of Precipitation (GSMaP)

http://sharaku.eorc.jaxa.jp/GSMaP/



We renewed our website!

Registered users:
4185 users
114 counties
(Sep. 2018)

- GSMaP is a blended Microwave-IR product and has been developed in Japan toward the GPM mission.
  - U.S. counterpart is “IMERG”
  - GSMaP (v6) data was reprocessed as reanalysis version (GSMaP_RNL) since Mar. 2000 period , and was open to the public in Apr. 2016, and new version, GSMaP (v7) was released in 17 Jan. 2017.
  - We submitted a book chapter (Kubota et al. 2018) to review the GPM-era GSMaP products (in the Springer Book on Satellite Precipitation).

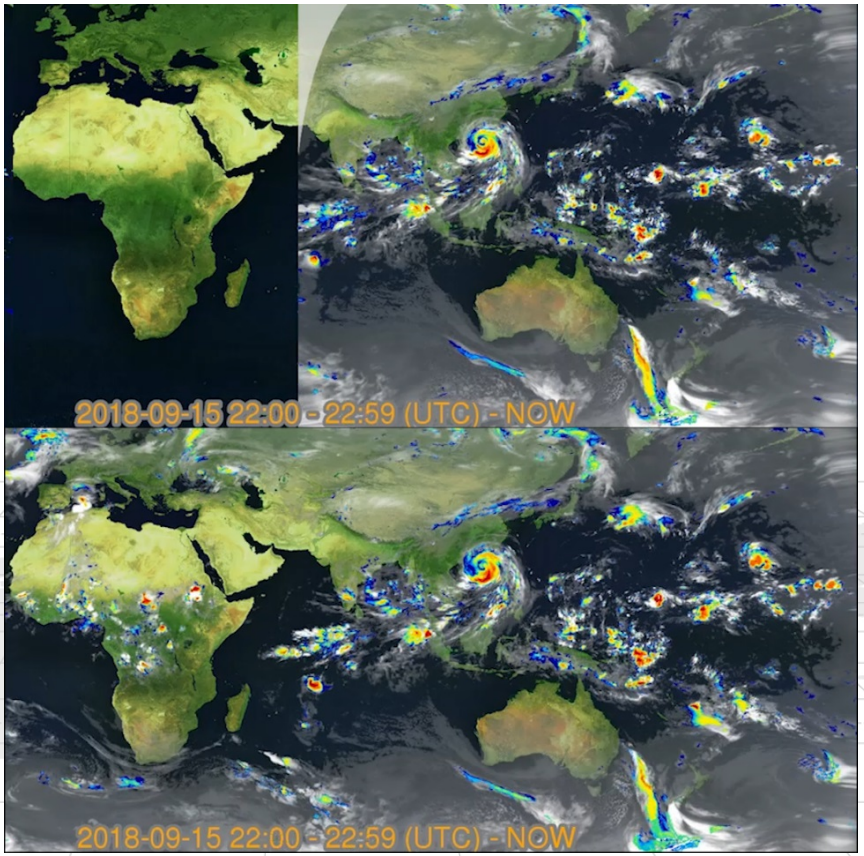
Extension of GSMaP_NOW

- JAXA has provided the GSMaP realtime product (GSMaP_NOW) in the domain of JMA GEO-Himawari since Nov. 2015.
  - The rainfall estimates are provided just now (0hr-latency)
- The GSMaP_NOW domain will be extended to the EUMETSAT GEO region (Meteosat/MSG) in this October.

Current GSMaP_NOW
(JMA GEO-Hiimawari region)

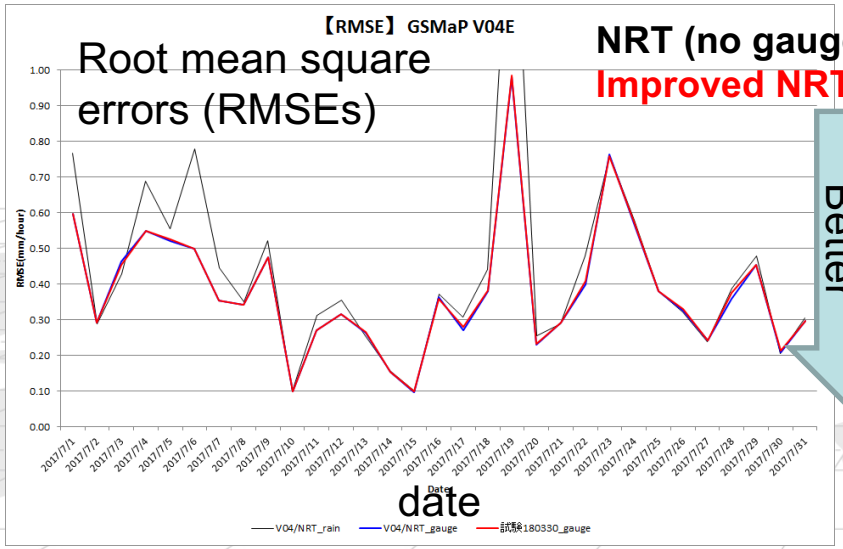
Updated GSMaP_NOW
(JMA GEO-Hiimawari region + EUMETSAT Meteosat/MSG)

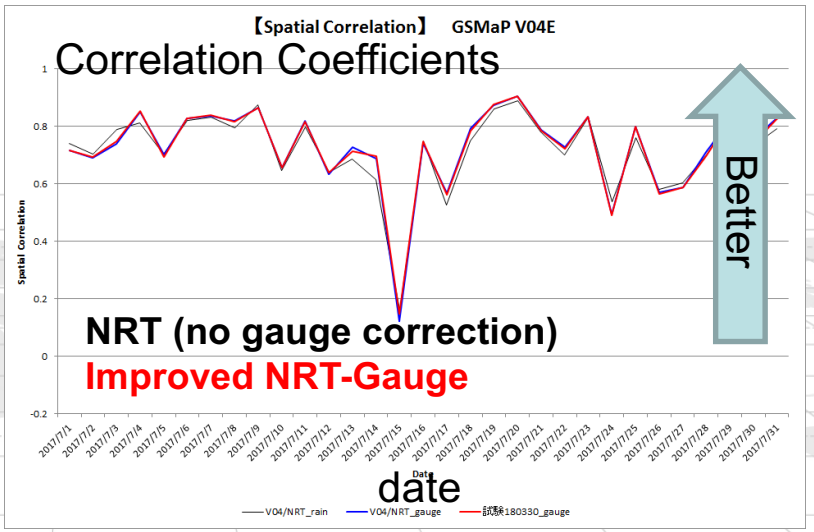
Extension of the NOAA GOES regions is on-going.



Improved NRT-basis Gauge-adjusted GSMaP product (v6)

- Improved NRT-basis Gauge-adjusted GSMaP product (v6) will be open to the public soon.
  - Correction coefficients are calculated using past 30 days.
  - We're now reprocessing past 18yr data record (since Mar. 2000)
- Validations with reference to the JMA radar around Japan show smaller RMSEs in this new product than the current NRT (no gauge-correction).





WMO SEMDP

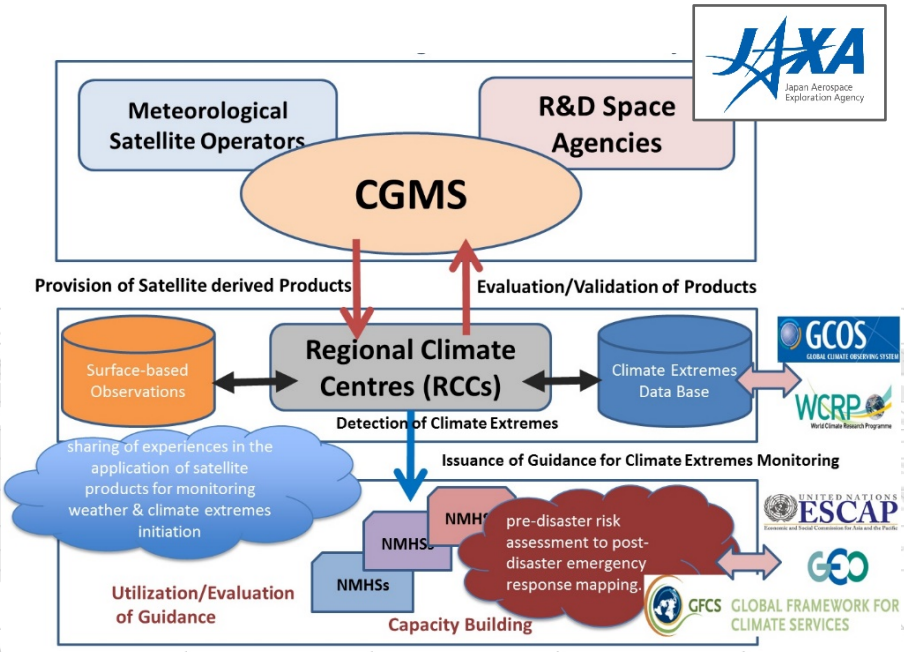
Space-based Weather and Climate Extremes Monitoring Demonstration Project

- WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP), East Asia and Western Pacific Regional Subproject initiated in 2018 with a duration of two years.
- JAXA attends this subproject with the GSMaP as one of Global Satellite-derived Products Providers (GP-SAT), and provide the NRT-basis Gauge-adjusted GSMaP product with 18yr-climate normal.

SEMDP Workshop on Mar. 2018 at Jakarta, Indonesia

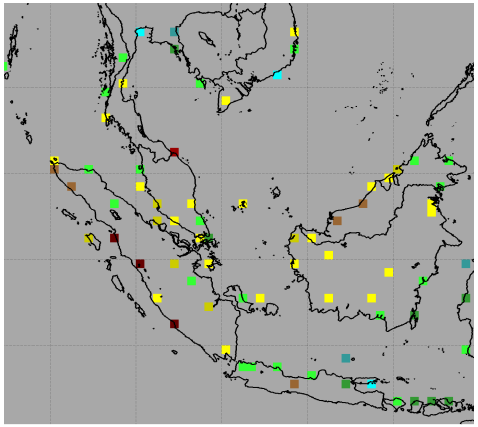
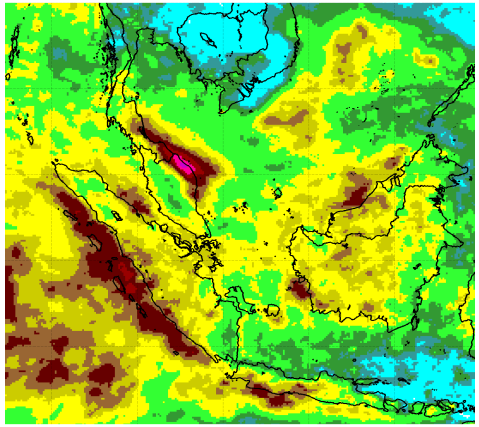
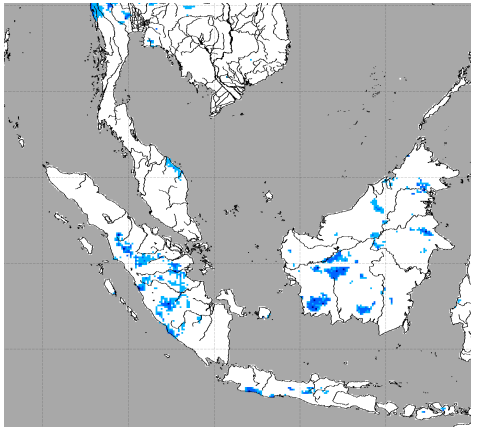
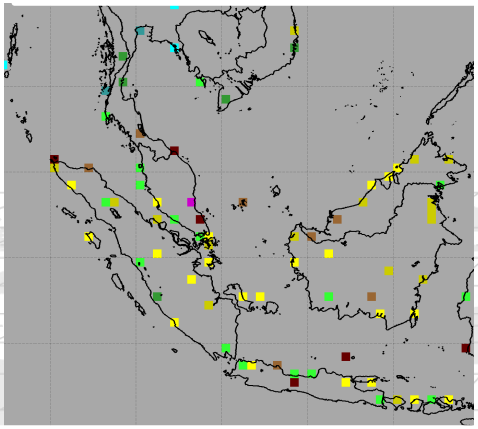
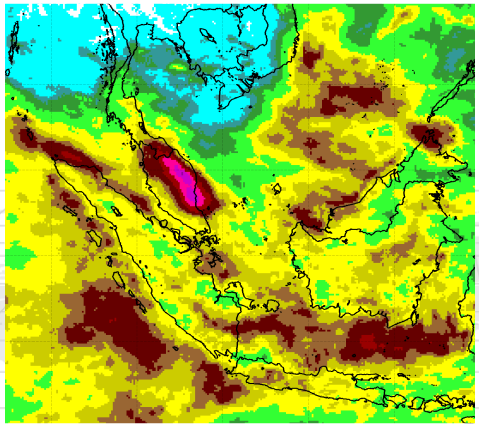
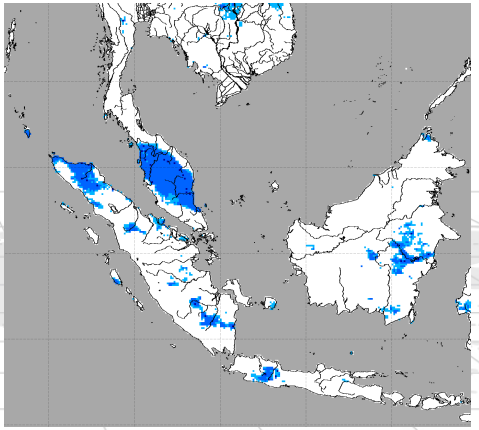
http://www.wmo.int/pages/prog/sat/meetings/SEMDP_Workshop/SEMDP_Workshop.html

SEMDP Implementation concept



http://www.wmo.int/pages/prog/sat/SEMDP/semdp_portal.html

Examples of Satellite-based Climate Extremes Monitoring

	Reporting gauges (0.5 deg)	GSMaP (v6) Gauge-NRT (0.1 deg)	Satellite Detected Region of Extreme Heavy Rainfall based upon percentiles from past 18-yr data
Nov 2014			
Dec 2014			

(mm/day)

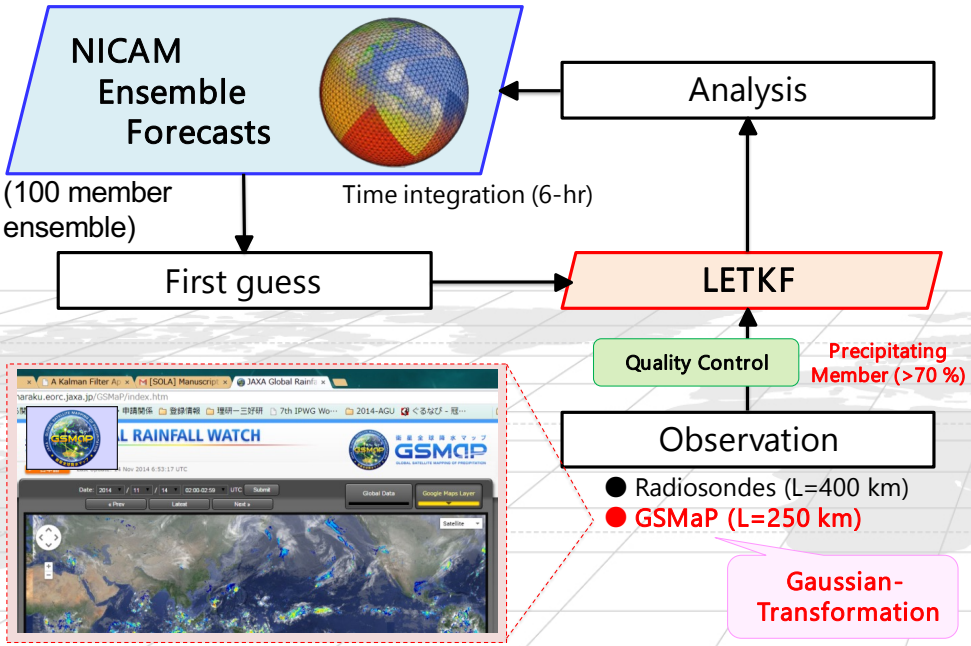
> 90th percentile
> 95th percentile
> 99th percentile

GSMaP assimilation in JAXA supercomputer system (NEXRA)

- JAXA, Univ. Tokyo and RIKEN installed the NICAM-LETKF data assimilation system using the GSMaP at JAXA supercomputer system generation 2 (JSS2) and has experimentally operated it in near-real time (see Dr. Kanemaru's poster #224).

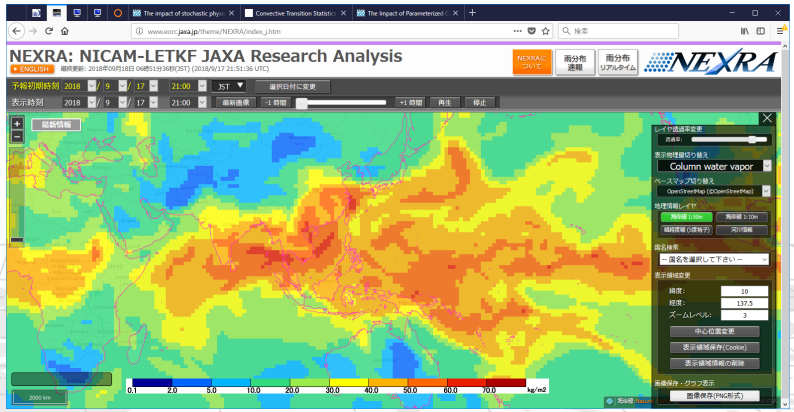
JSS2 SORA J-SPACE Data Assimilation Team AORI

Assimilating GSMaP with NICAM-LETKF



NICAM-LETKF at JAXA Research Analysis=NEXRA

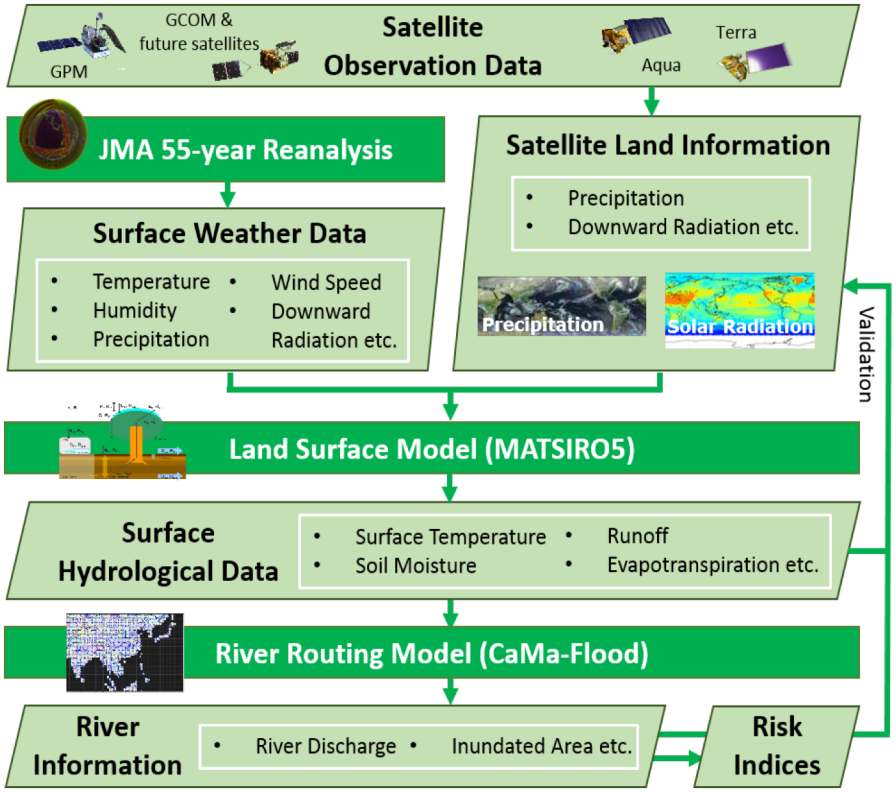
NEXRA



(Monitoring home page is now construction…)

Global Hydrological Simulation System; *Today's Earth*

- JAXA has developed the global hydrological simulation system "*Today's Earth*" under the joint research with University of Tokyo (see Mr. Yamamoto's poster #238).
- Over 50 hydrological variables simulated through 3 different experiments (shown below) are now accessible through the web page and ftp site.
  https://www.eorc.jaxa.jp/theme/water/



Exp. name	Spatial resol.	Temporal resol.	Period	Latency	Forcing
JRA55 ver.	0.5-deg (land) 0.25-deg (river)	3 hourly, daily, monthly	1958-present	About 3.5 days	JRA55 reanalysis
MODIS ver.	〃	〃	2002-present	About 20 days	JRA55 reanalysis （radiation→MODIS）
GSMaP ver.	〃	〃	2000-present	About 5 days	JRA55 reanalysis （precip.→GSMaP）

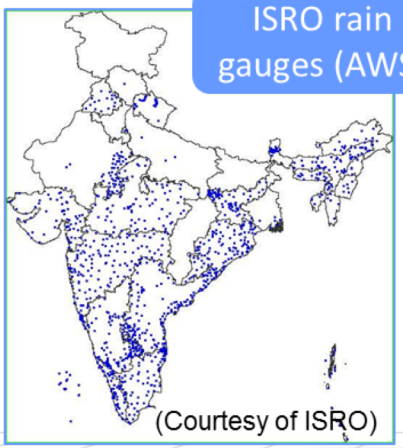
JAXA-ISRO collaboration:

Collaborative Activities on Improved Rainfall Products

- Under the Implementation Arrangement (IA) of the MOU, JAXA and ISRO participate in collaborative initiatives to
  - validate the satellite rainfall data (e.g. DPR & GSMaP) over India
  - related application research activities using the NWP and hydrological models

Ground instruments

ISRO rain gauges (AWS)



(Courtesy of ISRO)

ISRO ground weather radar

(Courtesy of ISRO)

Satellite rainfall products

validation/ improvement

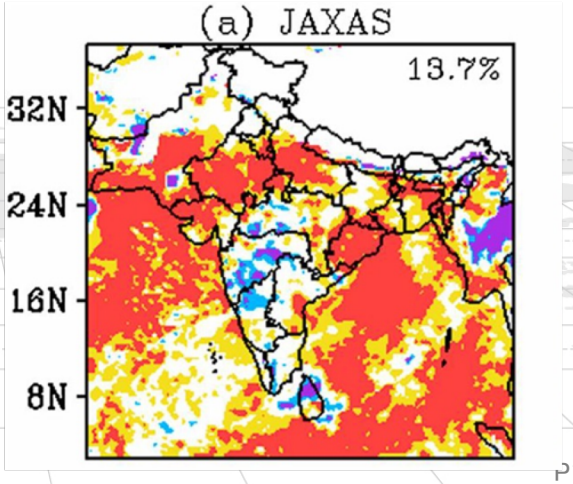
GSMaP

Dual-frequency Precipitation Radar

→ More accurate satellite rainfall products over the humid Asian countries

Application

Enhancement of activities in improved weather forecasts using the GSMaP
(Kumar et al. 2014, *JGR*)



[Outreach] GPM Symposium (Nov. 2017)

- JAXA GPM Symposium
  - Held on 29 Nov., 2017@Tokyo, Japan (co-organized by NASA, NICT)
  - Thank Drs. M. Freilich and G. Skofronick-Jackson (NASA) for presenting in the symposium!
- Background & Purpose
  - The prime mission operation of the GPM core satellite completed in 2017.
  - This symposium was held to inform the achievements & importance of TRMM-GPM measurement in public.
- 160 participants attended.
  - Many active discussions were made among the participants including students and new industry persons(e.g. civil engineering, agriculture, etc.)
  - 92% out of the participants answered ‘very satisfied’ about the symposium.

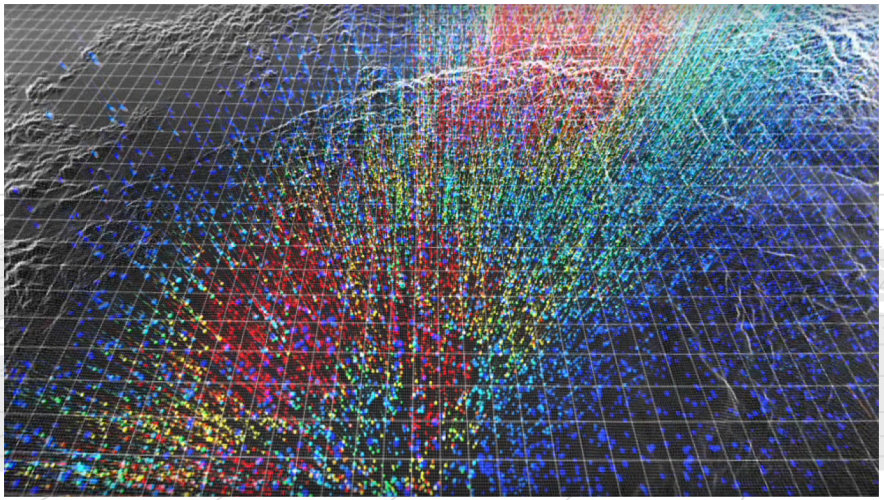
[Promotion] GPM Asia Workshop (Jan. 2018)

- The 7th GPM Asia Workshop on Satellite Precipitation Data Utilization
  - Held in Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), Jakarta, Indonesia, on 11-12 Jan., 2018
- Purpose of the workshop:
  - To promote satellite precipitation data utilization in Asia, and move forward research activities related to GPM in each country in working-level.
  - To share early validation and utilization results of the GPM products in Asian countries.
  - To proceed future collaborations between Japan and Asian countries.

[Outreach] 3D visualization of DPR data

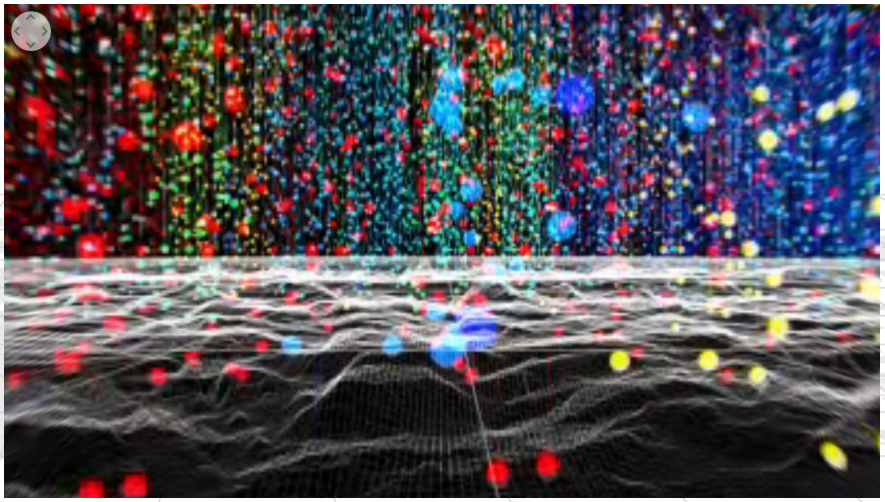
- JAXA developed the AR/VR system to visualize observation from GPM/DPR
  - AR : 360-deg. animation is now available on via YouTube channel of JAXA/EORC
  - VR : You can go through the image of :
    - Precipitation rate / DSD distribution / snow/rain classification

AR: Heavy Rain over west Japan in Jul. 2018



https://www.youtube.com/watch?v=6XLTgK1wPyw

AR: Typhoon 21 image in Sep. 2018

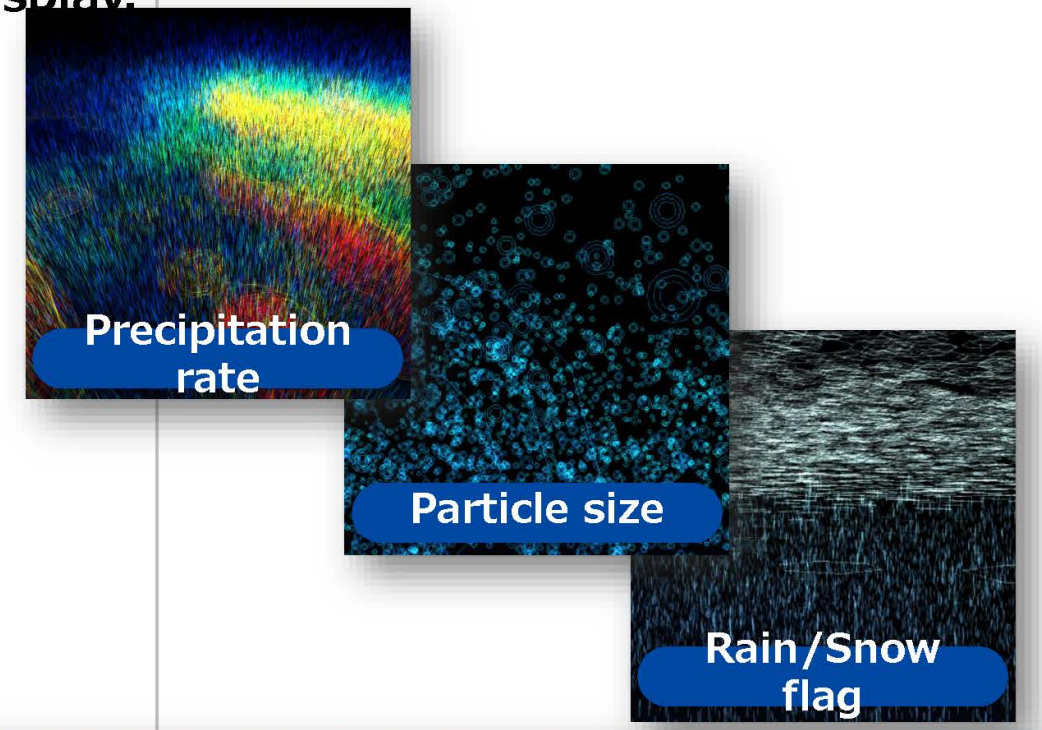


https://www.youtube.com/watch?v=6XLTgK1wPyw

[Outreach] Virtual Reality (VR) in JAXA

Virtual Reality: GPM/DPR 3D precipitation data

Virtual Reality (VR) visualization demonstration of 3D precipitation data observed by GPM/DPR. In this contents, player can fly around in a rainfall (typhoon), snowfall and directly see the satellite observation data using VR head mount display.



Summary

- The Japanese PMM Science Team started in Apr. 2013 for three-year period.
  - 41 proposals for the 8th RA (JFY2016-2018)
- GPM products V06 were recently released to the public.
  - Better continuity of the TRMM/PR (V8, GPM V06) and the GPM/KuPR V06
- Global rainfall map product (GSMaP)
  - The GSMaP_NOW domain will be extended to the EUMETSAT GEO region (Meteosat/MSG) in this October.
  - Improved NRT-basis Gauge-corrected GSMaP product will be released soon.
- Japanese application activity
  - NWP, Calibration of the ground radar using the DPR, Satellite-based Climate Extremes NEXRA, Today's Earth, and etc.
- Outreach/Promotion
  - GPM Symposium (Nov. 2017, Tokyo)
  - GPM Asia Workshop (Jan. 2018, Indonesia)
  - VR & AR of GPM/DPR data in JAXA